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# THE EFFECT OF HURRICANE HUGO ON BIRD POPULATIONS ON ST. CROIX, U.S. VIRGIN ISLANDS

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ABSTRACT.—Bird populations were sampled along road transects eight months after Hurricane Hugo struck St. Croix, at sites previously sampled on similar dates in 1987. Surveys revealed 33 species both before and after the hurricane, of which 30 species were detected during both samples. However, the average number of birds per stop was significantly lower after the storm's passage than before. No pattern was evident in the changes of aquatic species, but this may reflect limited sample sizes. Among terrestrial species, higher proportions of nectarivores and fruit/seedeaters declined than insectivores or raptors, suggesting that the storm's greatest stress occurred after its passage rather than during its impact. Populations of the Pearly-eyed Thrasher (*Margarops fuscatus*) declined on one transect and increased on another, a pattern consistent with inter-habitat migration. The fruit/seed diet, low population size, and restriction to remnant forest fragments of the Bridled Quail-Dove (*Geotrygon mystacea*) may explain the significant population decline of this species and its disappearance from traditional sites. *Received 9 Jan. 1992, accepted 15 April 1992.*

Hurricanes can have both direct and indirect effects on bird populations. Direct effects involve death from exposure to high winds and rain (Kennedy 1970). Indirect effects include destruction of food supplies or nesting, roosting, and foraging substrates by high winds (Jeggo and Taynton 1980, Engstrom and Evans 1990). Storm-weakened birds may be at greater risk to predation, particularly in the absence of vegetative cover or roosting sites for protection (Engstrom and Evans 1990). Normal migration patterns may be disrupted and, in some instances, change the geographic distribution of species (Thurber 1980). Furthermore, populations may increase in some habitats as a result of increased wandering, migration into new habitats, or the descent of canopy dwellers to ground level (Dunning and Watts 1991, Wunderle et al. 1992). Thus, if hurricanes occur frequently, as in the Caribbean, they may be important factors in determining some of the characteristics of the local avifauna (Wunderle et al. 1992).

Our study takes advantage of pre-hurricane baseline censuses of bird populations conducted along four roadside transects throughout 1987, prior to the arrival on 17 Sept. 1989 of Hurricane Hugo on the Caribbean island of St. Croix in the U.S. Virgin Islands. The baseline censuses were

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replicated eight months after the storm (May 1990) to evaluate its short-term effects on bird populations. This enabled us to document the response of bird populations to the direct impact of a very powerful storm (category 4 on the Saffir-Simpson scale of 5, Brennan 1991) on a relatively small (210 $km^2$), low lying (max. elevation 353 m) island which has been extensively deforested (Fig. 1).

## STUDY SITES AND METHODS

The senior author conducted point counts along roadside transects in four locations on St. Croix in 1987 and 1990. Four transects were selected along roads in rural areas, and stop sites along each transect were selected on the basis of accessibility and representation of habitat types. In 1987, topographic and cultural features and habitat characteristics were mapped for the area within approximately 122 m of each stop. Percentages of habitat types were derived later by placing a square mylar sheet over each map and counting the number of squares representing each type. Habitat classification follows Forman (1980) and reveals that the four transects were dominated by pasture/field (37%), thorn woodland (20%), deciduous forest (12%), semi-evergreen forest (10%), coastal hedge/grassland (6%), littoral woodland (5%), urban (4%), water (3%), cactus scrub (2%), and mangrove woodland (1%). However, the distribution of habitat types was not evenly distributed among the transects, as summarized below:

(A) The south shore transect (16.1 km, N = 25 stops; Fig. 2) follows St. Croix's south-central shoreline (Highway 60), beginning at the junction of the Grassy Point side-road and ending at the entrance to Cane Garden. The route is entirely within the subtropical dry forest life zone (Ewel and Whitmore 1973) with the following habitat types: pasture/field (56%); littoral woodland (12%); thorn woodland (11%); cactus scrub (7%); urban (7%); coastal hedge/grassland (5%); water (1%); and mangrove woodland (<1%).

(B) The north shore transect (11.3 km, N = 21 stops) follows the north-central shoreline (Highway 80), beginning at the junction of Highway 75 and ending at the junction with Highway 73. The route passes through the subtropical dry forest life zone (Ewel and Whitmore 1973) and includes the following habitat types: thorn scrub (34%); coastal hedge/grassland (18%); water (11%); pasture/field (10%); littoral woodland (9%); semi-evergreen forest (9%); deciduous forest (5%); mangrove woodland (2%); and urban (2%).

(C) The Castle Burke transect (8.1 km, N = 16 stops; Fig. 3) crosses St. Croix south to north at mid-island and runs through both the subtropical moist forest and subtropical dry forest life zones (Ewel and Whitmore 1973). It begins at the junction of Centerline Road (Highway 70) and Golden Grove Road and ends at the junction of Highways 69 and 80. The predominant habitat type here is pasture/field (48%); thorn woodland (23%); deciduous forest (17%); semi-evergreen forest (8%); urban (3%); and water (<1%).

(D) The moist forest transect (9.7 km, N = 23 stops; Fig. 4) runs through the northwest mountains and includes the Creque Dam Scenic Road. The route begins at the entrance to the Springfield Quarry on Mahogany Road (Highway 76) and ends at the junction of Creque Dam Road and Northside Drive (Highway 63). The route, within the subtropical moist forest life zone (Ewel and Whitmore 1973), includes pasture/field (38%); deciduous forest (23%); semi-evergreen forest (22%); thorn woodland (11%); urban (4%); and water (<1%).

Censuses were conducted by driving the transect routes during early morning, starting about 15 minutes before sunrise and ending before 07:45 h AST. No censuses were taken on mornings with excessive wind or rain. All birds were counted during a three-minute interval at each stop. The methods followed those of the "Breeding Bird Survey" (Robbins

FIG. 1. Salt River Mangrove Swamp habitat. Upper 1987 photo illustrates mature mangrove forest. Lower 1990 photo illustrates post-Hugo conditions; most mangroves were flattened and the deciduous forest habitat on adjacent hillsides was damaged but recovered much faster.

FIG. 2. South shore. Upper 1987 photo is of typical pasture near center of south shore route. Lower photo illustrates 1990 post-Hugo conditions.

FIG. 3. Castle Burke Pond. Upper 1987 photo is of mature semi-evergreen forest vegetation around pond edge. Lower 1990 photo illustrates post-Hugo habitat.

FIG. 4. Moist forest habitat. Upper 1987 photo illustrates gallery-forest conditions along the western end of Creque Dam Road. Lower photo is of 1990 post-Hugo habitat.

and Van Velzen 1967) with the exception that less than 50 stops were censused per route because of limited distances. Counts were taken bi-weekly throughout 1987 and two to three times in 1990.

Post-hurricane censuses, using the same methods established in 1987, were made between 6–18 May 1990 at the peak of the breeding season. Each transect was replicated on three non-consecutive mornings, except for the Castle Burke transect which was sampled on only two non-consecutive mornings. For each of the corresponding transects, post-hurricane results were compared with the closest pre-hurricane sample dates (22 April–30 May 1987). For each stop along a transect, we calculated the average (based on N = 3 or N = 2 replicated dates) number of birds detected before the storm and the average number detected after the storm. These values were then averaged to provide the mean number of birds per stop for each transect both before and after the storm. The distribution of total individuals among the stops on each transect was normal both before and after the hurricane, enabling us to use paired $t$-tests (Sokal and Rohlf 1981) to compare the pre- and post-hurricane averages of total individuals per stop. However, for over half the species, the distribution of individuals among the stops was not normally distributed. We therefore used nonparametric Mann-Whitney $U$-tests (Sokal and Rohlf 1981) to compare the pre- and post-hurricane distributions for individual species. A probability of type I error of 0.05 or less was accepted as significant, but we show greater values for descriptive purposes.

For each transect, we tallied the number of terrestrial species showing increases, no change, or decreases in average number of detections following the hurricane. Each species was classified as either a nectarivore, frugivore/seedeater, insectivore, or raptor on the basis of Wetmore (1916) and Faaborg (1985). This information was then analyzed in a row × column test of independence with a $G$-statistic (Sokal and Rohlf 1981).

## RESULTS

The average number of individual birds per stop, across all transects (N = 85 stops), was significantly lower after the hurricane than before (Table 1). However of the four individual transects, a significant decline (paired $t$-test, df = 24, $t = 8.62$, $P < 0.001$) was detected only on the south shore transect. Here, the decline was greater for terrestrial than for aquatic individuals. On the north shore transect, a significant increase was found in the average number of aquatic birds per stop, but the average for terrestrial birds was unchanged.

Wauer found 33 species (11 aquatic/22 terrestrial) on transects before the hurricane and 33 species (13 aquatic/20 terrestrial) afterwards (see Appendix I for scientific names). Thirty species were encountered both before and after, providing a turnover of three species detected only before and three species detected only after the hurricane. Of the species found only before the hurricane, the Green-backed Heron was rare (N = 1), the Antillean Crested Hummingbird was common and widespread (detected outside the transects after the hurricane), and the Bridled Quail-Dove was uncommon (max count = 5) and confined to the moist forest. The three species found only after the storm were all aquatic and occurred in low numbers (Pied-billed Grebe, N = 1; White-cheeked Pintail, N = 2; Common Moorhen, N = 3).

TABLE 1
CHANGES IN MEAN NUMBER OF INDIVIDUALS (± SE) PER STOP AND TOTAL NUMBER OF SPECIES ON FOUR TRANSECTS ON ST. CROIX BEFORE AND AFTER HURRICANE HUGO

| Transect | Individuals per stop[a] | | Total number of species | |
|---|---|---|---|---|
| | Before | After | Before | After |
| Castle Burke | | | | |
| Aquatic | 0.50 ± 0.30 | 0.25 ± 0.22 | 3 | 3 |
| Terrestrial | 23.40 ± 5.12 | 16.81 ± 0.97 | 18 | 17 |
| South shore | | | | |
| Aquatic | 1.52 ± 0.36 | 1.32 ± 0.51 | 10 | 10 |
| Terrestrial | 19.61 ± 1.18 | 10.35 ± 0.81* | 20 | 18 |
| North shore | | | | |
| Aquatic | 0.14 ± 0.09 | 0.44 ± 0.15* | 5 | 6 |
| Terrestrial | 12.81 ± 1.3 | 12.14 ± 1.18 | 19 | 17 |
| Moist forest | | | | |
| Aquatic | 0.00 ± 0.00 | 0.01 ± 0.01 | 0 | 1 |
| Terrestrial | 18.54 ± 0.77 | 17.26 ± 0.75 | 17 | 17 |
| Mean total | 19.01 ± 1.22 | 14.80 ± 0.53* | 33 | 33 |

[a] Mean ± SE; Aquatic and terrestrial individuals in each transect were compared with a paired *t*-test, * = $P < 0.05$.

When making a large number of statistical comparisons, some observations are expected to deviate significantly from expected value by chance alone. We performed 106 individual Mann-Whitney *U*-tests for population changes after the hurricane of which 10% (11) and 5% (5) are expected by chance at significance levels of 0.10 and 0.05, respectively. However, we found that 29 populations changed at $P \leq 0.10$ and that 22 populations changed at $P \leq 0.05$ (Appendix I). Furthermore, six populations showed changes at the level of 0.001, a very unlikely random event. Therefore, most of the population changes after the hurricane are not artifacts of the large number of comparisons.

Seventeen species showed significant or suggestive ($P \leq 0.10$) declines in mean number of individuals per stop on one or more of the transects (Appendix I). The number of suggestive or significant declines was greatest on the south shore transect (N = 14) followed by the moist forest transect (N = 5), north shore (N = 4), and Castle Burke (N = 1). These declines could result from either hurricane-induced mortality, movement to other habitats, or decreases in detectability.

Five species showed significant or suggestive increases in mean number of individuals per stop on one or more transects (Appendix I). Increasing populations (at $P \leq 0.10$) were most common on the moist forest transect (N = 4), followed by the north shore (N = 1), and Castle Burke transects (N = 1), and South Shore (N = 0). These increases could result from movement into a habitat, or because the birds were easier to detect as a result of vegetation damage.

Two species decreased along some transects and increased along others (Appendix I). Such observations are consistent with a migration explanation, but factors such as changes in detectability could also be involved.

For terrestrial species, we expected the pattern of population decline to vary with diet, with those species relying directly on plants for food most likely to decline. To examine this possibility, species were classified into four diet categories, and the number of populations that decreased was compared to those that either increased or showed no change. Pearly-eyed Thrashers, as extreme diet opportunists (McLaughlin and Roughgarden 1989), could not easily be placed in any of these categories, and therefore were excluded from the initial analysis. A significant interaction between diet type and population trend was found in the remaining populations along the four transects ($G = 10.81$, df = 3, $P = 0.013$), indicating that nectarivores and fruit/seedeaters were more likely to have declining populations than insectivores or raptors. Declines were found in 92% of the nectarivore populations (N = 12), 70% of the fruit/seedeater populations (N = 30), 58% of the insectivore populations (N = 24), and 25% of the raptor populations (N = 8) along the four transect routes.

The finding that terrestrial bird populations relying on plants for food were more likely to suffer declines than those relying on animals was quite robust, regardless of how the Pearly-eyed Thrasher is classified. For example, assuming thrashers are predators results in significantly more declines ($G = 7.04$, df = 1, $P = 0.008$) in populations of primary consumers (76%; 32/42) than secondary consumers (47%; 17/36). Even if thrashers are classified as frugivores, significantly ($G = 3.81$, df = 1, $P = 0.05$) more populations of primary consumers declined (72%; 33/46) than secondary consumers (50%; 16/32).

Previous studies have shown that apparent population increases after hurricanes may result from the presence of canopy dwellers foraging at ground level where they are easier to detect (Wunderle et al. 1992). To examine this possibility we classified all non-raptorial terrestrial species as either canopy dwellers or as ground/understory foragers (foraging on or within 1 m of the ground) on the basis of our previous observations. An analysis of population trends based on foraging site indicates that 37% of the canopy foragers (N = 41 populations) showed increasing populations, as did 31% of the ground/understory populations (N = 29 populations). Thus, population increases after the hurricane could not be attributed solely to an increase in canopy dwellers at ground level.

## DISCUSSION

As Hurricane Hugo approached St. Croix, the storm's forward speed slowed to 14.5 kph over a twelve-hour period, thereby prolonging the exposure of the island to the storm's fury (Brennan 1991). The eye of the storm crossed the southwestern coastline of St. Croix near Frederiksted at about 02:00 h AST on 18 September 1989. After the storm, trained observers deduced from the damage, including the entire island's vegetation, which was literally stripped bare, that all of St. Croix experienced the storm's maximum winds (estimated at 226 kph). Given the island's relatively small size and limited topographic relief it is unlikely that any major natural "refugia" existed which might have harbored bird populations or their food supplies.

All transects received the full impact of the storm, with vegetation damage most severe in areas with tall-stature vegetation, and least severe in the open habitats. Subjective assessments of vegetation damage were not necessarily accurate predictors of the storm's impact on bird populations. For example, population declines were most frequent and often most severe on the south shore transect, which contained the highest percentage of pasture (56%). Even though declines here were also less severe in secondary than in primary consumers, 83% (5/6) of insectivores declined. For some species (e.g., Gray Kingbird) open pastures may have been a habitat in which most population declines were attributable to mortality due to the direct effects of the storm, rather than to resource shortages in its aftermath.

Semi-evergreen and deciduous forests suffered extensive structural damage, as sampled along the moist forest transect and parts of the Castle Burke transect. Yet these transects had the lowest percentages of populations with declining population trends (Castle Burke 58%; moist forest 45%) and several species showed suggestive ($P < 0.10$) or significant ($P < 0.05$) population increases. Population increases associated with major structural damage to tall-stature forests were found in Jamaican mangroves and wet limestone forest after Hurricane Gilbert (Wunderle et al. 1992) and in the El Verde rainforest in Puerto Rico, immediately after the passage of Hurricane Hugo (Waide 1991). There population increases in storm-damaged forests have been attributed to increased detectability, wandering, migration, and the presence of canopy dwellers foraging at ground level. Our results suggest that the latter was probably not important in contributing to the population increases observed on St. Croix.

Our results are consistent with studies that indicate that population declines in the aftermath of hurricanes are most likely among nectarivores and fruit/seedeaters and less likely among insectivores or raptors. Recent hurricane studies have documented this pattern in sites with varying degrees of vegetation damage in a diversity of habitats, including lowland rainforests of Nicaragua (Boucher 1990), subtropical dry forests in the Yucatan (Lynch 1991), montane habitats in Jamaica (Wunderle et al., 1992), subtropical wet forest in Puerto Rico (Waide 1991), subtropical dry forest on Guadeloupe (Bénito-Espinal and Bénito-Espinal 1991), and subtropical dry woodland and subtropical moist forest on St. John (Askins and Ewert 1991). These results are not unexpected given that hurricane winds strip flowers, fruits, and seeds from plants, which often require many months or even years for recovery (Wunderle, unpubl. data). In contrast, some arthropod populations are unaffected by the storm, and those that are affected often have high recovery rates (Wolcott 1932). In some instances, major outbreaks of arthropods have occurred in the aftermath of hurricanes (Torres, in press).

Some insectivore declines did occur (e.g., Black-whiskered Vireo, Mangrove Cuckoo, Yellow Warbler), particularly if their foraging substrates had been lost. The massive mortality of mangroves undoubtedly contributed to the Yellow Warbler's decline. In contrast, on Jamaica the number of Yellow Warblers had increased in surviving mangrove remnants four months after the hurricane's passage (Wunderle et al. 1992). In this species, moderate to high levels of vegetation damage (stem and branch breakage) contribute to higher local population densities concentrated in relatively intact remnant vegetation, but outright tree mortality (trunk snaps or uprooting) results in population decline. For insectivores whose foraging substrates were not lost, such as Cattle Egrets, the storm had no effect on the number of individuals observed at foraging sites. However, Cattle Egrets were largely absent from their traditional roost site at Castle Burke Pond where more than 100 egrets regularly roosted in large trees prior to the destruction of the site.

One species that may not have survived the hurricane or its aftermath is the Bridled Quail-Dove, a previously rare, fruit/seedeater that was confined to remnant forest fragments on St. Croix. This quail-dove was not detected on our transects after the hurricane, and a search at another traditional site at Caledonia Gut also failed, despite the production of low whistle sounds that previously had evoked responses. Bridled Quail-Doves appear to be sensitive to openings in the forest canopy, as demonstrated by the related Ruddy Quail-Dove (*Geotrygon montana*), which disappeared from areas with extensive canopy damage in the aftermath of Hurricane Hugo in the Luquillo Experimental Forest in Puerto Rico

(Waide 1991). In Puerto Rico, Ruddy Quail-Doves persist in undamaged patches of forest scattered throughout continuous forest (11,330 ha), and in other forest reserves that were unaffected by the storm. In contrast, on St. Croix Bridled Quail-Doves were locally confined to small remnant forest fragments. Extensive damage to these fragments left the species with few, if any, potential refugia, thereby increasing the likelihood of local extinction. A similar scenario (severe fragmentation of the habitat of a forest-dwelling fruit/seedeater followed by hurricane impacts) may have contributed to the extinction of the Puerto Rican Bullfinch (*Loxigilla portoricensis grandis*) on St. Kitts (Raffaele 1977), and is likely to be more common in the future as habitat fragmentation continues in hurricane-prone regions.

Many of the hurricane's effects observed in the St. Croix avifauna were also noted by Askins and Ewert (1991) on the nearby island of St. John (64 km north), which was out of the storm's main path and suffered considerably less damage. St. John's forest was extensively defoliated, with frequent broken branches and occasional treefalls. Despite the relatively light damage on St. John, Askins and Ewert also observed the pattern of diet-related population declines, with significant reductions in the numbers of Scaly-naped Pigeon, Antillean Crested Hummingbird, Bananaquit, and Pearly-eyed Thrasher in either moist forest or dry woodlands. These authors also documented an increase in Northern Waterthrushes (*Seiurus noveboracensis*), suggesting movement into a habitat from a badly damaged site elsewhere. Thus even with relatively light storm damage, population declines can occur due to mortality or emigration from the disturbed site.

Despite Hurricane Hugo's tremendous force and the extensive damage to St. Croix, terrestrial bird population declines were still primarily related to diet, indicating that the hurricane's greatest stress occurred after its passage rather than during its impact. Therefore the ability to use a variety of disturbed habitats appears to be a key predictor of post-hurricane survival in many terrestrial birds. Indeed, most of the terrestrial species on St. Croix (with the exception of Bridled Quail-Doves) are common in a variety of human-disturbed habitats, and thus it is not surprising that most survived this destructive storm with reasonably intact populations. Most of the bird species that occur on St. Croix are widespread geographically in the Caribbean and their ability to use various disturbed habitats has probably facilitated their survival in this hurricane-prone region.

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## Appendix I

Mean (± SE) Number of Individuals per Stop before (Upper Row) and after (Lower Row) Hurricane Hugo on Four Transects on St. Croix[a]

| Species | Diet | Transect: Castle Burke | South shore | North shore | Moist forest |
|---|---|---|---|---|---|
| Pied-billed Grebe | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Podilymbus podiceps*) | | 0.06 ± 0.06 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Brown Pelican | | 0.38 ± 0.23 | 0.01 ± 0.01 | 0.02 ± 0.02 | 0.00 ± 0.00 |
| (*Pelecanus occidentalis*) | | 0.00 ± 0.00 | 0.11 ± 0.05 | 0.06 ± 0.04 | 0.00 ± 0.00 |
| Magnificent Frigatebird | | 0.00 ± 0.00 | 0.67 ± 0.19 | 0.02 ± 0.02 | 0.00 ± 0.00 |
| (*Fregata magnificens*) | | 0.00 ± 0.00 | 0.69 ± 0.50 | 0.06 ± 0.04 | 0.00 ± 0.00 |
| Great Blue Heron | | 0.03 ± 0.03 | 0.01 ± 0.01 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Ardea herodias*) | | 0.00 ± 0.00 | 0.01 ± 0.01 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Great Egret | | 0.06 ± 0.04 | 0.16 ± 0.05 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Casmerodius albus*) | | 0.16 ± 0.13 | 0.11 ± 0.05 | 0.10 ± 0.07 | 0.01 ± 0.01 |
| Little Blue Heron | | 0.00 ± 0.00 | 0.01 ± 0.01 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Egretta caerulea*) | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.03 ± 0.02 | 0.00 ± 0.00 |
| Cattle Egret | I | 8.59 ± 4.59 | 0.96 ± 0.25 | 0.02 ± 0.02 | 0.03 ± 0.02 |
| (*Bubulcus ibis*) | | 1.28 ± 0.45 | 1.52 ± 0.34 | 0.57 ± 0.25* | 0.64 ± 0.22* |
| Green-backed Heron | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.02 ± 0.02 | 0.00 ± 0.00 |
| (*Butorides striatus*) | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| White-cheeked Pintail | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Anas bahamensis*) | | 0.00 ± 0.00 | 0.03 ± 0.03 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Red-tailed Hawk | R | 0.06 ± 0.04 | 0.00 ± 0.00 | 0.03 ± 0.33 | 0.06 ± 0.03 |
| (*Buteo jamaicensis*) | | 0.03 ± 0.03 | 0.01 ± 0.01 | 0.33 ± 0.03 | 0.16 ± 0.07 |
| American Kestral | R | 0.03 ± 0.03 | 0.05 ± 0.03 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Falco sparverius*) | | 0.03 ± 0.03 | 0.01 ± 0.01 | 0.02 ± 0.02 | 0.04 ± 0.03 |

## Appendix I
Continued

| Species | Diet | Transect: Castle Burke | Transect: South shore | Transect: North shore | Transect: Moist forest |
|---|---|---|---|---|---|
| Helmeted Guineafowl | F | 0.00 ± 0.00 | 0.81 ± 0.80 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Phasianus meleagris*) | | 0.00 ± 0.00 | 0.44 ± 0.31 | 0.32 ± 0.03 | 0.03 ± 0.03 |
| Common Moorhen | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Gallinula chloropus*) | | 0.03 ± 0.03 | 0.01 ± 0.01 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Killdeer | | 0.00 ± 0.00 | 0.11 ± 0.05 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Charadrius vociferus*) | | 0.00 ± 0.00 | 0.05 ± 0.03 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Black-necked Stilt | | 0.00 ± 0.00 | 0.05 ± 0.03 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Himantopus mexicanus*) | | 0.00 ± 0.00 | 0.05 ± 0.04 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Laughing Gull | | 0.00 ± 0.00 | 0.13 ± 0.09 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Larus atricilla*) | | 0.00 ± 0.00 | 0.13 ± 0.09 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Royal Tern | | 0.00 ± 0.00 | 0.24 ± 0.21 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| (*Sterna maxima*) | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.08 ± 0.06 | 0.00 ± 0.00 |
| Least Tern | | 0.00 ± 0.00 | 0.12 ± 0.05 | 0.10 ± 0.07 | 0.00 ± 0.00 |
| (*Sterna antillarum*) | | 0.00 ± 0.00 | 0.12 ± 0.05 | 0.14 ± 0.08 | 0.00 ± 0.00 |
| Rock Dove | F | 0.00 ± 0.00 | 0.04 ± 0.04 | 0.02 ± 0.16 | 0.00 ± 0.00 |
| (*Columba livia*) | | 0.25 ± 0.25 | 0.27 ± 0.03 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Scaly-naped Pigeon | F | 2.59 ± 0.36 | 0.07 ± 0.04 | 1.56 ± 0.41 | 3.51 ± 0.32 |
| (*Columba squamosa*) | | 2.16 ± 0.32 | 0.00 ± 0.00 | 1.06 ± 0.22 | 2.81 ± 0.31 |
| White-crowned Pigeon | F | 0.00 ± 0.00 | 0.09 ± 0.04 | 0.13 ± 0.11 | 0.00 ± 0.00 |
| (*Columba leucocephala*) | | 0.00 ± 0.00 | 0.01 ± 0.01* | 0.37 ± 0.21 | 0.00 ± 0.00 |
| Zenaida Dove | F | 0.97 ± 0.23 | 1.67 ± 0.41 | 1.46 ± 0.23 | 1.42 ± 0.17 |
| (*Zenaida aurita*) | | 1.31 ± 0.26 | 0.69 ± 0.17* | 1.32 ± 0.21 | 1.54 ± 0.17 |
| Common Ground-Dove | F | 0.84 ± 0.19 | 3.32 ± 0.51 | 0.43 ± 0.12 | 0.81 ± 0.16 |

## Appendix I
Continued

| Species | Diet | Transect: Castle Burke | South shore | North shore | Moist forest |
|---|---|---|---|---|---|
| (*Columbina passerina*) | | 0.69 ± 0.18 | 0.85 ± 0.15* | 0.11 ± 0.06* | 0.64 ± 0.14 |
| Bridled Quail-Dove | F | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.14 ± 0.05 |
| (*Geotrygon mystacea*) | | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00* |
| Mangrove Cuckoo | I | 0.22 ± 0.09 | 0.15 ± 0.04 | 0.33 ± 0.07 | 0.22 ± 0.07 |
| (*Coccyzus minor*) | | 0.19 ± 0.08 | 0.05 ± 0.02 | 0.02 ± 0.02* | 0.10 ± 0.05 |
| Smooth-billed Ani | I | 0.03 ± 0.03 | 0.73 ± 0.20 | 0.02 ± 0.02 | 0.20 ± 0.10 |
| (*Crotophaga ani*) | | 0.34 ± 0.17 | 0.52 ± 0.12 | 0.13 ± 0.07 | 0.30 ± 0.12 |
| Green-throated Carib | N | 0.03 ± 0.03 | 0.07 ± 0.03 | 0.02 ± 0.02 | 0.00 ± 0.00 |
| (*Eulampis holosericeus*) | | 0.00 ± 0.00 | 0.00 ± 0.00* | 0.00 ± 0.00 | 0.01 ± 0.01 |
| Antillean Crest. Humm. | N | 0.19 ± 0.08 | 0.22 ± 0.10 | 0.95 ± 0.41 | 0.19 ± 0.10 |
| (*Orthorhyncus cristatus*) | | 0.00 ± 0.00* | 0.00 ± 0.00* | 0.00 ± 0.00* | 0.00 ± 0.00* |
| Caribbean Elaenia | F | 0.25 ± 0.11 | 1.08 ± 0.20 | 0.49 ± 0.14 | 0.22 ± 0.12 |
| (*Elaenia martinica*) | | 0.47 ± 0.21 | 0.88 ± 0.22 | 0.48 ± 0.12 | 0.71 ± 0.24 |
| Gray Kingbird | I | 3.53 ± 0.42 | 2.47 ± 0.18 | 2.02 ± 0.29 | 2.28 ± 0.24 |
| (*Tyrannus dominicensis*) | | 3.22 ± 0.44 | 1.57 ± 0.19* | 2.00 ± 0.28 | 2.52 ± 0.23 |
| Northern Mockingbird | F | 0.31 ± 0.11 | 0.87 ± 0.12 | 0.10 ± 0.07 | 0.03 ± 0.02 |
| (*Mimus polyglottos*) | | 0.22 ± 0.11 | 0.13 ± 0.05* | 0.00 ± 0.00 | 0.00 ± 0.00 |
| Pearly-eyed Thrasher | F | 1.56 ± 0.29 | 0.19 ± 0.05 | 2.31 ± 0.51 | 6.13 ± 0.37 |
| (*Margarops fuscatus*) | | 2.66 ± 0.38* | 0.37 ± 0.11 | 2.87 ± 0.54 | 4.48 ± 0.26* |
| Black-whiskered Vireo | I | 0.91 ± 0.16 | 0.72 ± 0.09 | 0.60 ± 0.16 | 0.51 ± 0.13 |
| (*Vireo altiloquus*) | | 1.21 ± 0.18 | 0.37 ± 0.06* | 0.48 ± 0.14 | 0.68 ± 0.14 |

## Appendix I
Continued

| Species | Diet | Transect: Castle Burke | South shore | North shore | Moist forest |
|---|---|---|---|---|---|
| Yellow Warbler | I | 1.06 ± 0.24 | 2.49 ± 0.22 | 1.21 ± 0.26 | 0.65 ± 0.18 |
| (*Dendroica petechia*) | | 1.00 ± 0.18 | 1.65 ± 0.20* | 1.03 ± 0.21 | 0.65 ± 0.19 |
| Bananaquit | N | 1.56 ± 0.26 | 2.31 ± 0.21 | 1.51 ± 0.19 | 2.03 ± 0.23 |
| (*Coereba flaveola*) | | 0.69 ± 0.16* | 0.75 ± 0.13* | 1.05 ± 0.12* | 1.58 ± 0.17 |
| Black-faced Grassquit | F | 0.66 ± 0.16 | 1.36 ± 0.18 | 0.60 ± 0.14 | 0.16 ± 0.07 |
| (*Tiaris bicolor*) | | 1.13 ± 0.26 | 0.51 ± 0.11* | 0.57 ± 0.17 | 0.36 ± 0.09 |

[a] Number of stops per transect are as follows: Castle Burke (N = 16); South shore (N = 25); North shore (N = 21); Moist forest (N = 23). Diet is classified for terrestrial foragers: F = fruit or seed; N = nectar; I = insect, O = omnivore; R = raptor. Significant differences ($P < 0.05$) between counts before and after the hurricane are indicated by *.